SYSTEM REQUIREMENTS REVIEW (SRR)

E120/Mobility

"Promoting Sensorimotor Response Generalizability: A Countermeasure to Mitigate Locomotor Dysfunction After Long-Duration Space Flight"

Agenda

- Introduction, Purpose and Objectives
- Project Overview and History
- Mobility Design Requirements
- Project Status
  - Testing and Analysis to date
- Schedule and Risks
- Summary and Action

Purpose

- Describe the functional and design requirements for the experiment unique equipment system
- Review system level verification requirements
  - Show the flow of requirements from the applicable documents to be baselined in the System Requirements Document (SRD).
- Provide general design information and preliminary operational concepts for the ISS community.
- Review the Mobility interfaces to the Treadmill Control Panel and the ISS Service Module (SM).

Objectives

- Provide clear requirements definition and obtain concurrence from EA, SA and all other supporting organizations for the Human Research Facility (HRF) Mobility Experiment hardware.
- Receive authorization to proceed to the design life cycle phase.
- Provide a status of the project issues and risks identified to date.

Key Personnel

• EB Technical Monitor	EB4/ Liz Bauer
• Experiment Systems Manager:	SM3/Carla Guidry
• Principal Investigator:	SK2/Jacob J. Bloomberg, Ph.D.
• Experiment Project Lead:	LMSO/Keith Tucker
• Experiment Support Scientist:	LMSO/Alicia Foerster
• Hardware Engineers:	LMSO/Alan Leyman
	LMSO/ Huong Charles
	LMSO/Peter Nystrom
	LMSO/Akash Patel
	LMSO/Richard Yao
• Systems Engineering	LMSO/Bret Garner LMSO/Larry Walters
• Safety	LMSO/Nancy Wilson
• Human Factors	LMSO/Cindy Hudy

Review Board Responsibilities

- Attend and participate in the SRR.
- Review the disposition of all RIDs.
- Disposition any RIDs that the hardware team and the RID initiator cannot agree on.
- Assess the success of the review and determine any constraints to proceeding directly to CDR.

Review Board Members

- EA24/R. Schwarz* — Project Management Office/Payload Rep. (Co-chair)
- SM3/C. Haven* — Human Research Program Manager (Co-chair)
- CB/L.D. Stevenson* — HRF Astronaut Office Rep.
- EB/J. LeBlanc* — Chief, Biomedical Systems Division
- NT3/J. Stanford* — Flight Equipment Division, GFE Branch

* Or designee

Timetable for the Review

- Requirements Data available 8/20/2003
- SRR Presentation 9/03/2003
- Deadline for submitting RIDs 9/17/2003
- RID Review 9/30/2003*
  - *Postponed from 9/25/2003. Scheduled to begin at 10:30am in the B57 Conference Room.

Project / Experiment Overview

- The goal of the study is to develop an inflight treadmill training protocol that enhances adaptive generalization of locomotor function after long-duration space flight.
- The approach is to integrate with the existing ISS treadmill procedure to create a countermeasure system designed to enhance postflight locomotor function by systematically manipulating body load, speed and visual tasking during treadmill locomotion.
    - The visual tasking portion requires the Mobility experiment hardware.

Existing Treadmill Vibration Isolation System (TVIS): Showing current display mounting with crew member walking

Project/Experiment Overview cont.

- The experiment has two in-flight elements
  - Treadmill Training Protocol
    - Crew member exercises on treadmill while watching visual scenes.
      - Treadmill is loaded and in active mode.
  - Visual Acuity Test (VAT)
    - Eye test in two parts
      - Static- Treadmill not operating
      - Dynamic- Treadmill in active mode, subject walking

Experiment Objectives

- Develop and validate procedures necessary to implement a sensorimotor variable practice treadmill training protocol in a weightless environment.
- Determine if the proposed inflight treadmill training protocol facilitates recovery of locomotor function following long-duration space flight on the ISS.

Operational Objectives

- To provide a single platform to conduct the experiment and normal TVIS operations
- Time constraints mandate easily configured system

Hardware Objectives

- To develop the necessary hardware to facilitate the experiment needs.
- To provide an easily configurable mounting scheme that incorporates the TVIS control panel to accommodate all astronauts, even those not choosing to be experiment participants.
- To provide certified hardware that can safely operate within the Service Module.

Document under Review

- Human Research Facility (HRF) Mobility System Requirements Document LS-71116
  - Developed the Mobility System Requirements Document (SRD) from a common HRF template.
    - Combines the elements of the Project Technical Requirements Specification (PTRS) and Verification and Validation Document (V&VD) in a single document similar to the Project Requirements and Verification Document (PRVD) which is described in EA-WI-023.

Mobility SRD

- The Mobility SRD requirements are broken into functional groupings such as:
  - Functional Requirements
  - Safety Requirements
  - Quality, Reliability and Workmanship Specifications
  - Interface Verification Requirements (ISS and Russian)

SRD Requirements

- Functional (PI) Requirements
  - Specific functional requirements imposed on the HRF Mobility Hardware flow from the draft SM3 Memo of Agreement (MOA), which will be incorporated into the Experiment Document.
- Safety Requirements
  - Safety requirements, which flow from NSTS 1700.7 (current rev and Addendums) are common for all payloads, however, each hardware will have specific safety verifications which are tracked through the Safety Verification Tracking Log (SVTL) and processed by the Payload Safety Review Panel (PSRP).
  - PSRP will include a review of Russian safety issues unique to the service module.

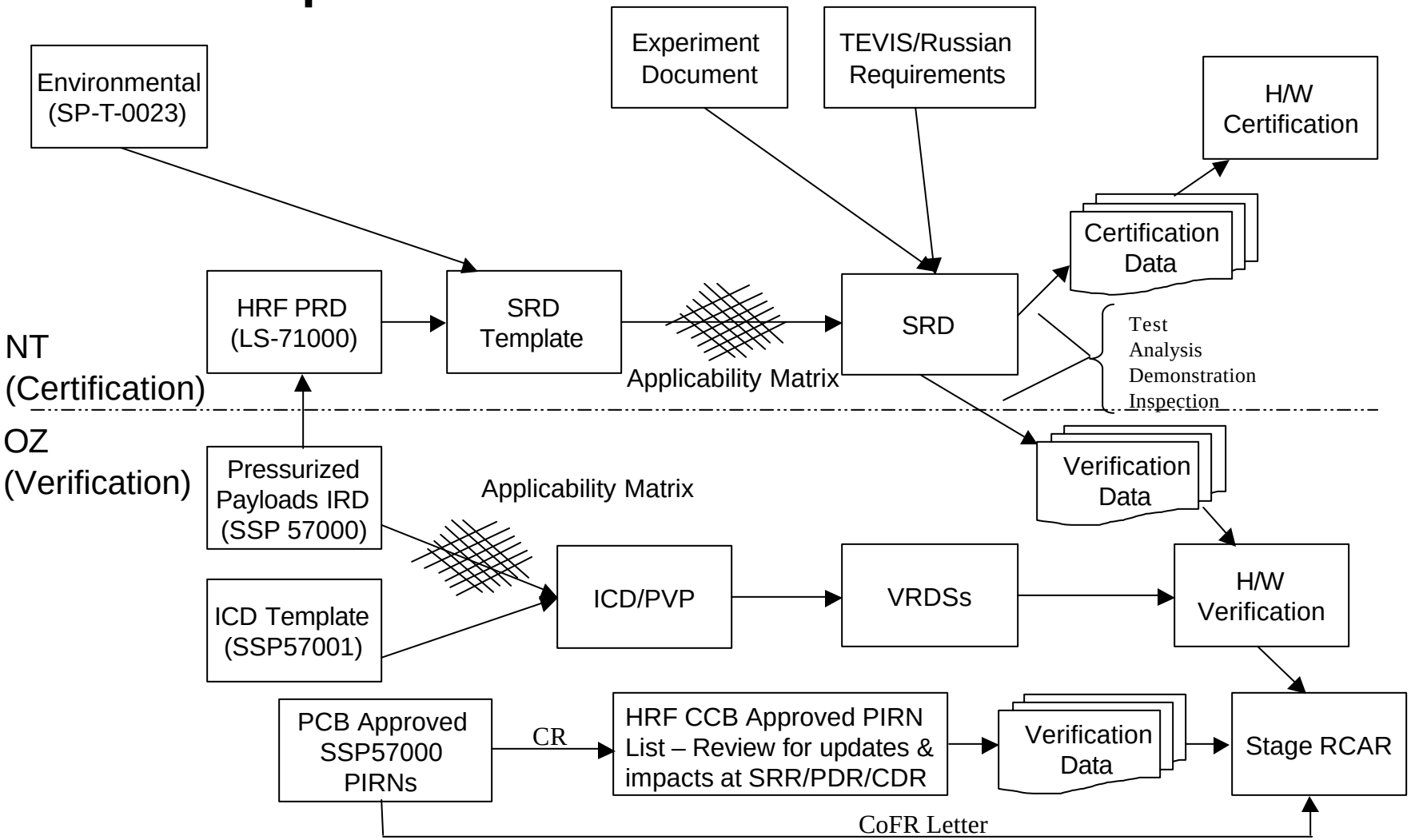
SRD Requirements continued

- Quality, Reliability and Workmanship Specifications
  - Quality, Reliability and Workmanship requirements are used to verify that sound products are being designed and built to latest quality standards. These requirements flow from HRF program level document LS-71000B.
- Verification Requirements
  - Verification requirements flow from the HRF program requirement document LS-71000B and Russian 50094.

Mobility SRD Appendices

- Relevant Appendices:
  - Appendix A – Reserved
  - Appendix B – ISS Pressurized Payload Interface Requirements Document Verification Matrix
  - Appendix C – Functional Performance Verification Matrix
  - Appendix D – Acceptance and Qualification Test Applicability Matrices
  - Appendix E – ISS Russian Segment Verification Matrix

Requirements Definition and Flow Down



Functional/PI Requirements

- For Treadmill Training Protocol, a 22" LCD monitor is required.
  - Required to meet field of view at 0.5 meters
- The Visual Acuity Test requires a monitor with dot pitch less than 0.12 mm. (at least many grayscale levels) running at full resolution.
  - Needed to measure a 20/16 optotype at 0.5 meters
- Video processor that will run visual scene benchmark in either AVI format or real-time rendering.
  - The graphics card must be capable of drawing 14.9 MTriangles per second.

Functional/PI Requirements (concluded)

- Data storage capacity for visual scenes and VAT results is 200 gigabytes.
  - Note: Only 1Kb of data will be recorded per session to later be transferred to the laptop.
  - Note: 1 min. duration of current scene is 800 megabytes in .AVI format
- Required input device is a "joystick"/"thumbstick." Must be single hand operable while walking on treadmill.

Resource Requirements

PROPERTIES	Requirement
MASS:	Approx. 34 kg
MAX. POWER REQUIREMENT	400 Watts for VAT
ENERGY/COOLING	300 Watts for TTP

The Service Module has a 20A, 28 Volt output that will be required by the Mobility Experiment.

Software Requirements

- The following are the functional/PI requirements:
  - Windows 2000 (Service Pack 3) OS
  - Vizard 1.1 for Windows 2000/NT/XP
  - Media Player 9.0 for Windows 2000/NT/XP
  - NI LabVIEW for Windows 2000/NT/XP/Me/9x

Experiment Software

- All experiment unique software (visual scenes and Visual Acuity Test) will be developed by the PI team.
  - Software package will include combination of Vizard, Windows Media Player, and Labview.
- Operating System (Windows 2000) and drivers will be provided through the nominal EB to SM HRF tasks.
- Software integration will be performed by HRF.

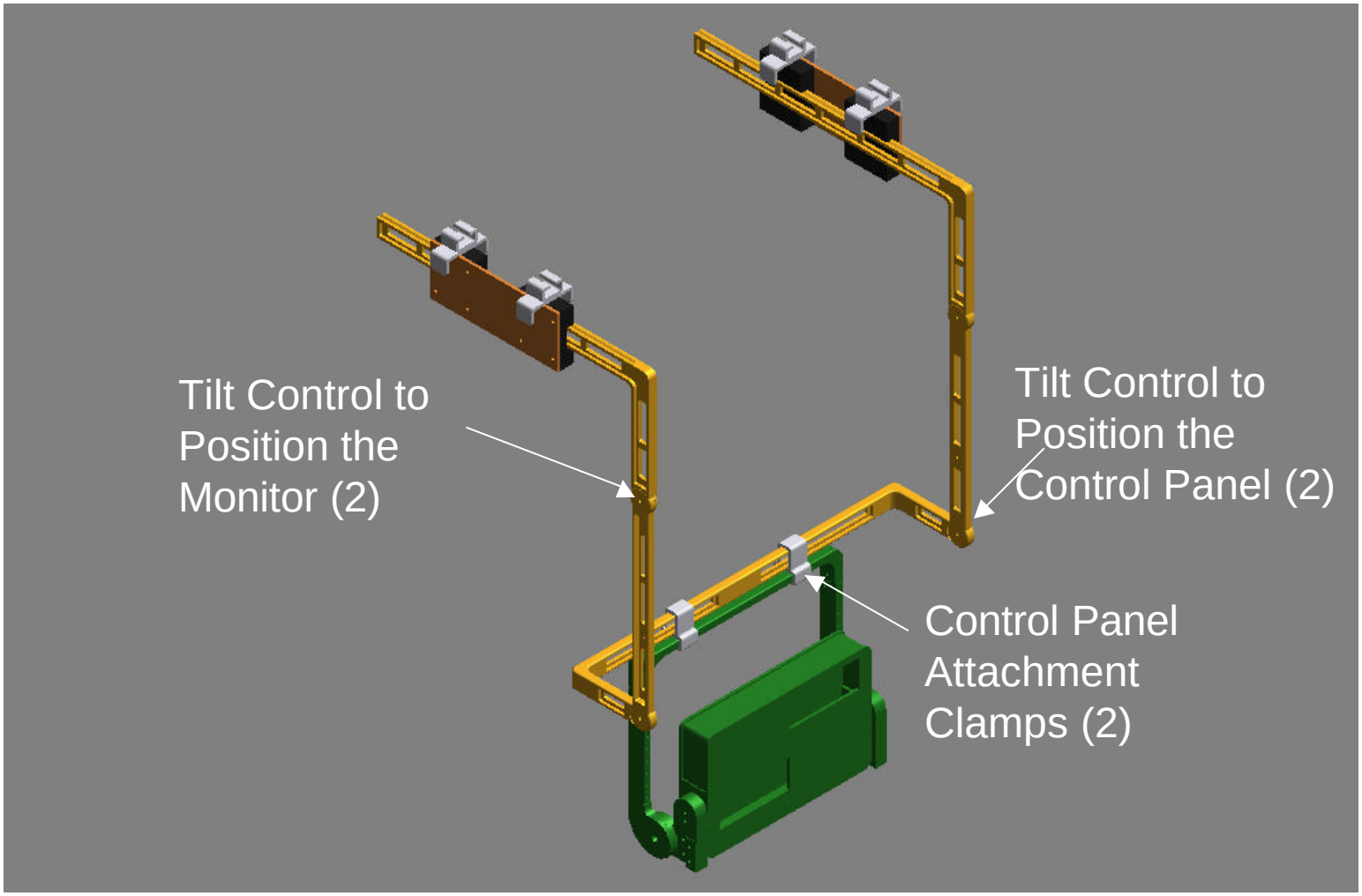
Mechanical Design Requirements

- Mechanical Requirements
  - 50 cm (19.7 in.) viewing distance from subject
  - Horizontal: ± 4.4 cm (or 1.7 in.) left or right of nominal (± 5° of head yaw rotation)
  - Vertical: ± 8.8 cm (or 3.5 in.) above or below nominal (± 10° of head pitch rotation)
- Manual adjustment of display angle in yaw, pitch, or roll (orientation/glare)
  - ± 5° play in yaw
  - ± 5° play in pitch
  - ± 5° play in roll
    - Adjustments required to reduce glare.

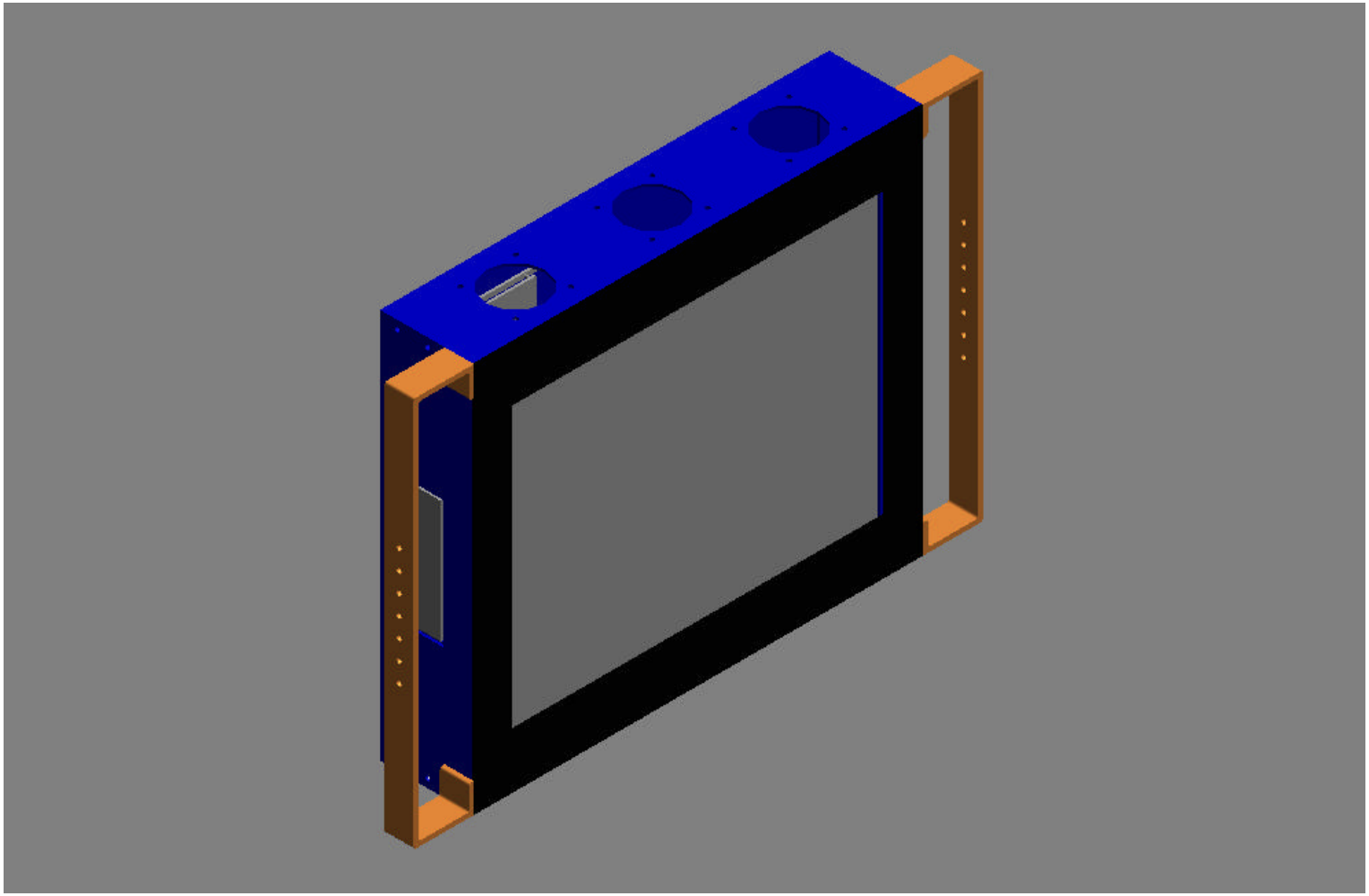
Hardware Overview

- 4 Main Assemblies
  - Mobility Mount
    - Interfaces to SM Ceiling Racks and the TVIS Control Panel
  - Mobility Graphics Display (MGD)
    - LCD computer, used to support treadmill training portion of the experiment
  - Mobility Visual Acuity Display (MVAD)
    - Small display with .12 pixel pitch for VAT protocol.
  - Mouse

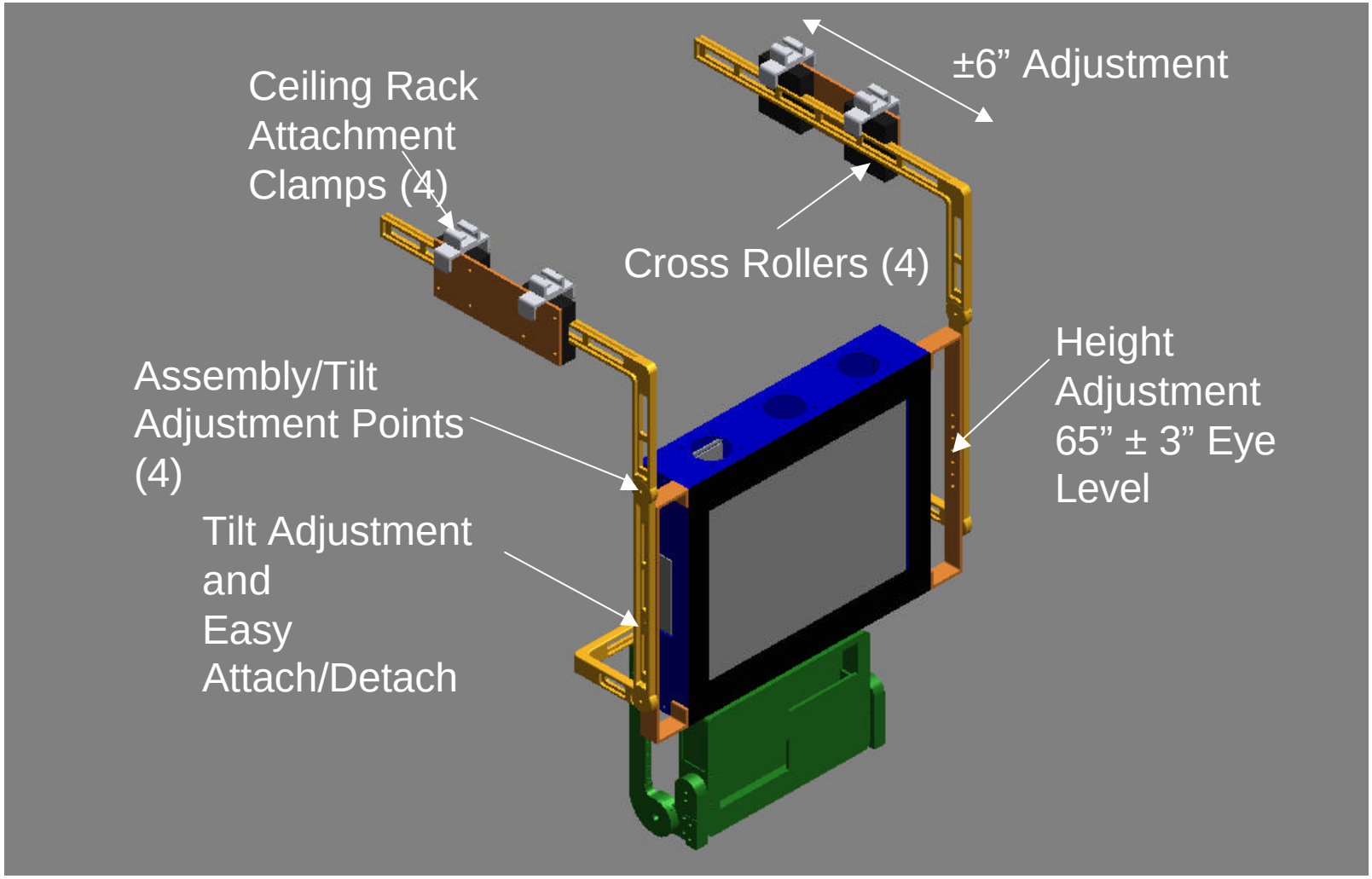
Mobility Mount with TVIS Control Panel



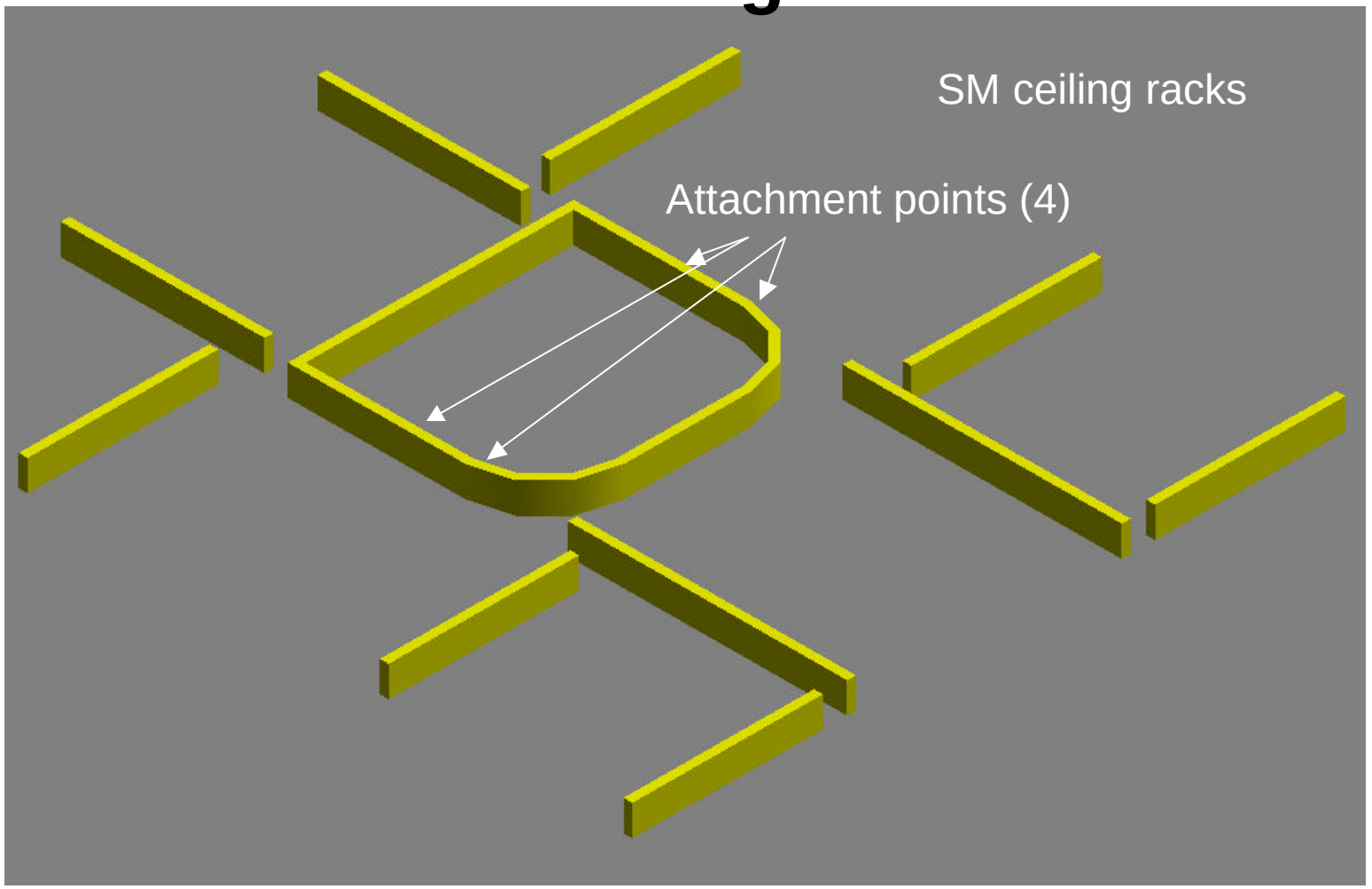
Mobility Graphics Display



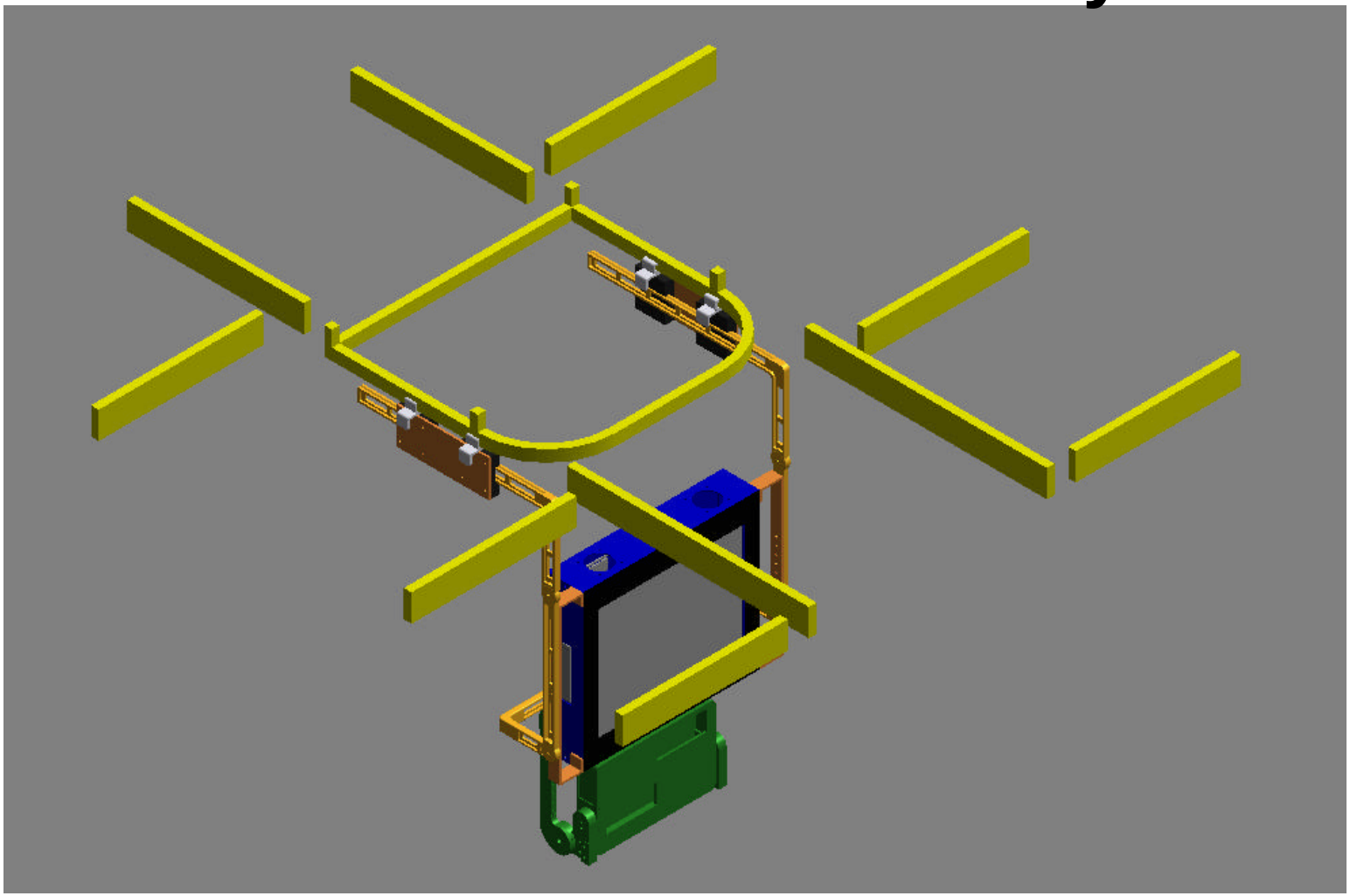
Integrated Mobility Mount



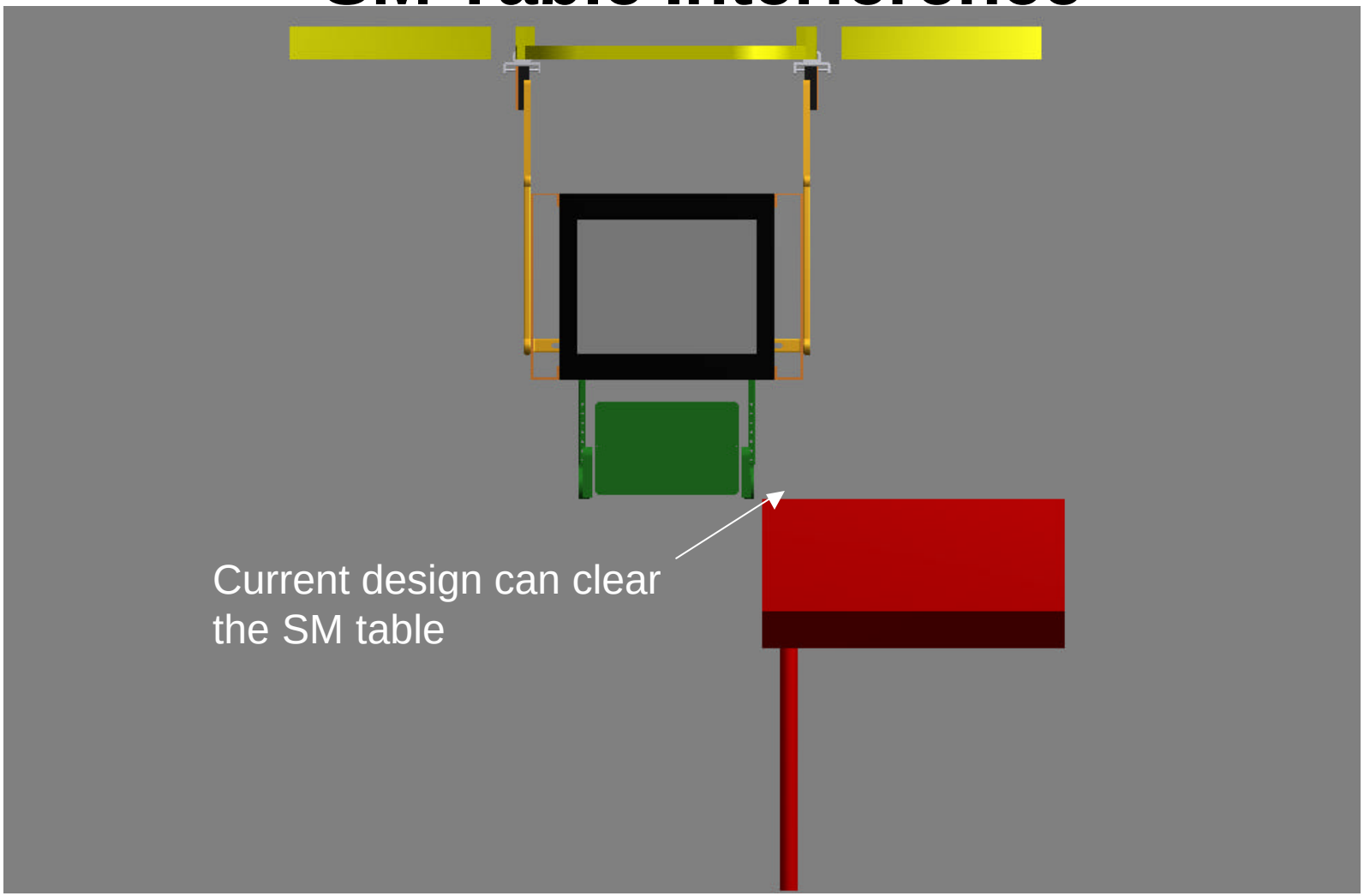
SM Ceiling Racks



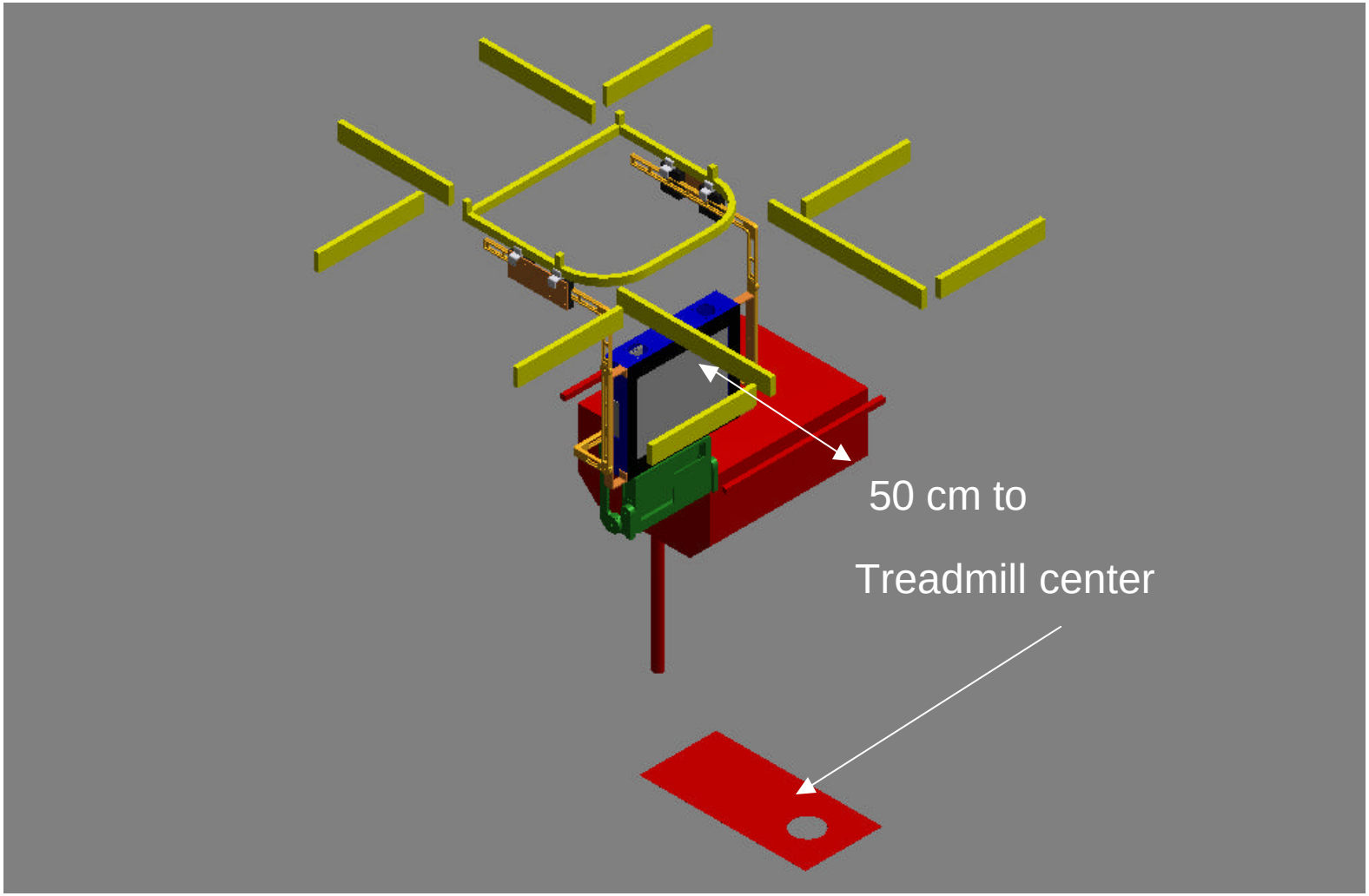
Rack Mounted Mobility



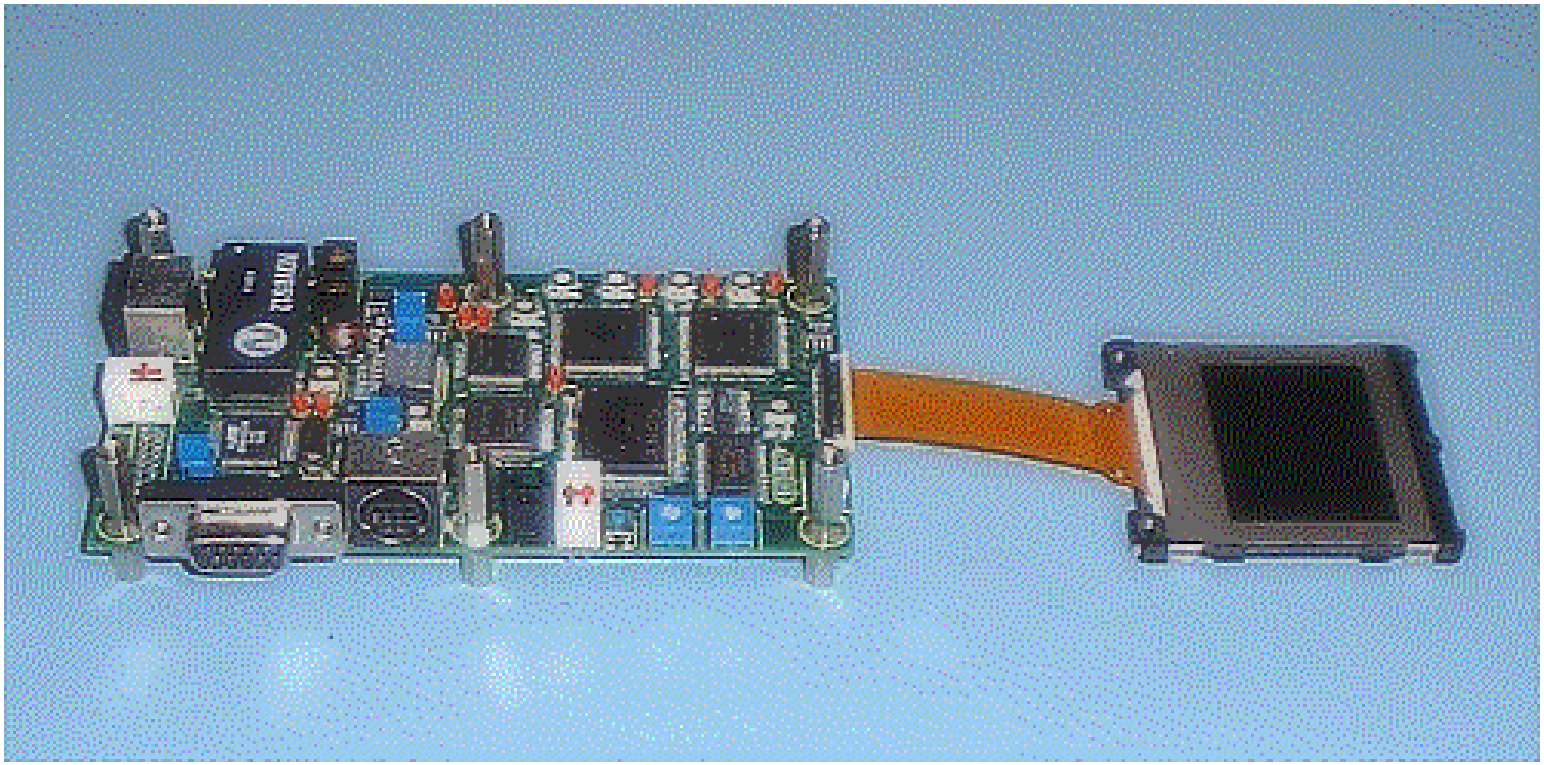
SM Table Interference



Overall ISO View



Mobility Visual Acuity Display Electronics with LCD



Mobility Mouse

Project Status

- Completed the Mobility Main Display prototype and performed feasibility studies using baselined scenes provided by the PI Team.
- The PI team conducted a study using the prototype and determined it meets the requirements for the Treadmill Training portion of the experiment.

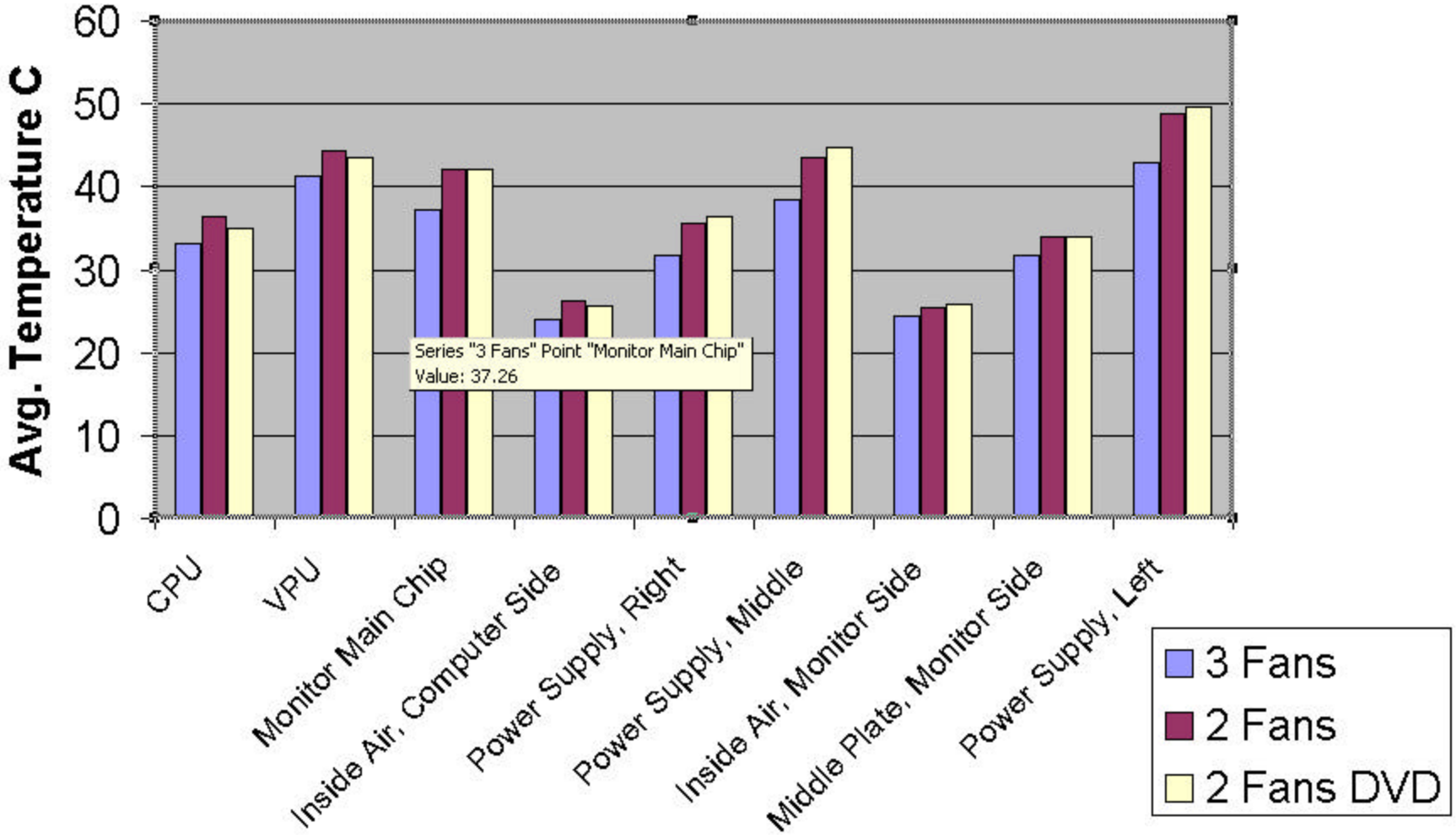
Project Status (concluded)

- The experiment was presented at the July 16 SPRT. Met with EB3, SM, and EA4 to discuss resources. Further discussions regarding TVIS interface will be conducted.
- The BME IPT gave the go ahead for the Mobility experiment on August 6.
- After PI testing was complete, some basic engineering information was collected to measure acoustic noise and internal temperatures to help with the final design.

Acoustic Results

Overall **Prototype 0.3m**	**56.4 dBA**
Overall **Prototype 0.6m**	**53.1 dBA**
Background	**44.5 dBA**

Thermal Study results



SCHEDULE
and
OPEN ISSUES/CONCERNS

Schedule

Task	Finish
Original ERR	11/16/99
HQ Approval	05/2000
Pre-flight Increment 5 BDC activities	10/2001
Delta ERR	6/18/03
System Requirements Review	9/3/03
Experiment PDR	9/11/03
Phase 0/1 Safety Review Package	10/1/03
Prototype/Trainer unit to PI Team	12/29/03
Experiment CDR	1/9/04
Hardware CDR	2/12/04
Hardware Delivery	1/3/05
Launch on ULF-2	TBD

Forward Work and Open Issues

- The inflight portion of this experiment requires interfacing Mobility hardware with the TVIS Control Panel, which is part of the ISS CHeCS hardware.
  - The process for negotiating flight use of CHeCS hardware is currently TBD, although discussions were initiated and will continue with the SPRT and EB3 lead.
- There is no formal agreement in place for use of Mobility experiment hardware in the Russian Service Module
  - A formal agreement between ISS and the Russian Space Agency will have to be negotiated via the Joint American Russian Safety Working Group (JARSWG).
  - First requires kick-off with Team Zero.
  - Joint Cargo Certification Team (JCCT) will review interfaces, requirements, and certifications.
  - Safety package is reviewed by PSRP and JCCT.

Summary

- Requirements have been properly identified and documented.
- All RIDs are due by Wednesday, September 17th.
- RID Review will commence on September 30 for formal disposition of all RIDs received.
- The HRF Mobility Experiment SRD will be submitted for signature following completion of the RID Review.